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The author's purpose in this paper is to explain and illustrate four principles for designing learning environments within which even young children can acquire complex symbolic skills with relative ease. After discussing the principles themselves and the theoretical system out of which they emerged, the author considers an illustrative application of these principles to the problem of designing an actual learning environment. Four principles for designing clarifying environments are (1) Perspectives Principle-one environment is more conducive to learning than another if it both permits and facilitates taking of more perspectives toward whatever is to be learned (2) Autotelic Principle-one environment is more conducive to learning than another if the activities carried on within it are more autotelic; (3) Productive Principle- one environment is more conducive to learning than another if what is to be learned within it is more productive. (4) Personalization Principle- one environment is more conducive to learning than another if it is more responsive to learner activities and permits and facilitates the learner's taking a more reflexive view of himself as a learner. As an illustrative example of a clarifying environment, the author discusses the talking typewriter. (Author/CJ)

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SOME PRINCIPLES FOR THE DESIGN OF CLARIFYING EDUCATIONAL ENVIRONMENTS

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SOME PRINCIPLES FOR THE DESIGN OF CLARIFYING EDUCATIONAL ENVIRONMENTS

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Preprint of a chapter to appear in David Goslin (Ed.), Handbook of Socialization Theory and Research. Chicago: Rand McNally, 1968. (in press)

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Contents

Theoretical Background 3
    Folk Models 3
    Personality 9
    Information Processing 12
    Information Processing for Human Beings 14
    Order of Mastering Perspective 15
    Complications Concerning Kind-Heartedness 15
Interlude 17
Principles for Designing Clarifying Environments 20
    Perspectives Principle. 21
    Autotelic Principle 24
    Productive Principle 26
    Personalization Principle 28
An Application of the Four Principles 31
    Perspectives Principle--Application 32
    Autotelic Principle--Applications 40
    Productive Principle--Application 45
    Personalization Principle--Application 47
Conclusion 56
References 58

SOME PRINCIPLES FOR THE DESIGN OF CLARIFYING EDUCATIONAL ENVIRONMENTS*

by

Omar Khayyam Moore
Alan Ross Anderson

When the ordinary typewriter was an exciting novelty, Mark Twain, who was an early typewriter buff, called it a "curiosity-breeding little joker"--and so it was, then. The talking typewriter, invented by Moore and Kobler [Moore, Kobler (1963), Kobler, Moore (1966)], is a contemporary novelty which also elicits a good deal of curiosity. There have been numerous popular articles about it, and most of those who have played with it find it fascinating. Unfortunately, the interest generated by this machine does not carry over, necessarily, to the theoretical ideas which lie behind it. We say "unfortunately" for good reason. The machine itself is less important than the principles which guided its construction. The talking typewriter is merely one of a large number of possible inventions which can be made, we think, using this same theoretical context as a guide.

Our main purpose in this paper is to explain and to illustrate a set of principles, four in number, for designing learning environments within which even very young children can acquire complex symbolic skills with relative ease. We intend to show, as we go along, that these principles for designing clarifying educational environments (where by a "clarifying educational environment" we mean an educational environment aimed to make the student [subject? victim?] clear about what he is doing, and more generally, what is going on) are systematically related to both a theoretical analysis of human culture and an interpretation of the socialization process, i.e., that process whereby a human infant,

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beginning life as a biological individual, becomes a person--and whose infantile behavior is gradually transformed into adult conduct.

In order to understand the "design principles" alluded to above, we must first explain the theoretical system out of which they emerged. We will then go on to a statement of the principles themselves, and finally we will consider, in some detail, an illustrative application of these principles to the problem of designing an actual learning environment. At this point, we will have come full circle--the talking typewriter will appear in a meaningful context as one part of a learning environment.

It will also be obvious that the talking typewriter is itself fundamentally a "social science invention." Because it is a social science invention, it is difficult to use it or similar devices intelligently without an appreciation of the social scientific ideas on which it is based.

Finally, before turning to our first task, that of sketching out the theoretical system upon which the set of principles is founded, we wish to acknowledge the contributions to our thinking of George Herbert Mead (1932, 1934, 1936, 1938),[1] the father of the Symbolic interactionist position in social psychology, and Georg Simmel [English translation (1959)], the originator of the school of Formal Sociology. We regard these men as central figures in the creation of the kind of sociology which can yield applications both at the level of mechanical inventions and social inventions. It may seem strange to some that we believe that Mead and Simmel have ideas which lend themselves to applications. Mead and his followers often have been criticized for spawning ideas which lacked testable consequences--to say nothing of applications; and to the best of our knowledge we are the only ones who have seriously entertained the thought that Simmel was within a light year of a practical application. We hope to show here that leading ideas taken from these two men can be reshaped into working principles for designing educational environments.

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[1] From time to time we will try to acknowledge our indebtedness to various authors, but a complete list of those authors to whom we feel indebted would be impossible for either of us to make out.

Theoretical Background[2]

Folk Models

We think that it is a mistake to regard the ordinary human being as an atheoretical or a nontheoretical or even an antitheoretical creature. Some contemporary behavioral scientists seem to assume that the ordinary man, a citizen in good standing in whatever community he lives, is woefully lacking in intellectual resources to guide him in managing his affairs. He is credited only with some folk sayings and proverbs, some practical knowledge, some skill at rule-of-thumb reasoning, some tradition-based explanations--and that is about it.

In a contrary vein, we suggest a different view of "man." We think that early in human history, probably at about the time men developed natural languages, they also created models of the most important features of their relations with the environment.[3] These were relatively abstract models which collectively covered relations holding between (1) man and nature--insofar as nature is not random, (2) man and the random or chancy elements in experience, (3) man in his interactional relations with others like himself, and (4) man and the normative aspects of group living. Cultural structures falling within these four classes of models were created in early history by many unsung Edisons and Einsteins (perhaps it would be more appropriate to say that they were created by the unsung Meads and Simmels of prehistory). Consequently, there does not exist a society however "primitive" that does not have cultural objects falling within these four categories of models. It is convenient to have a name for all four classes of models, a name that suggests their origin early in human history. We call them "folk models."

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[2] Since this section is mainly a summary of our own ideas, some worked out jointly, some separately, we have felt free to paraphrase our own papers without specific references. However, anyone who wishes to go more deeply into these ideas should read [A.R. Anderson, Moore (1959, 1962, 1966), Moore (1957, 1958, 1961, 1964, 1965, 1968), Moore, A.R. Anderson (1960a, 1960b, 1960c, 1962a, 1962b, 1968)].

[3] In common with many contemporary philosophers, we acquire a certain sick feeling when hearing talk about "man," or even worse, "Man." When one reads translations of Aristotle, and finds that "Man is a rational animal," one has the idea that something deep is going on, but obvious parallels ("Whale is a large animal," "Mouse is a small animal") make the locution seem as ludicrous as it is.

We nevertheless defer to a tradition, with the understanding that when we use the term "man" we are referring to human beings, and that, in consequence, all the appropriate verbs should be in the plural.

Every society, as far back as we have any evidence, has puzzles which, we suggest, stand in an abstract way for nonaleatory man-nature relations. Every society has some games of chance. According to our view of the matter, games of chance are abstract models of the aleatory aspects of existence. Every society has games of strategy in the sense of von Neumann (1947). These games capture some of the peculiar features of interactional relations among men, relations in which no party to an encounter controls all of the relevant variables upon which the final outcome depends, though each controls some of these variables and each participant must take some account of the potential actions of others involved in the situation if he is to behave intelligently. Every society has aesthetic entities, i.e., art forms which we claim give people the opportunity to make normative judgments about and evaluations of their experience. All societies make use of these folk models in the socialization of the young and for the re-creation, or recreational enjoyment, of those who are older. Simple forms of these models are internalized in childhood and more complex versions of them sustain us in adulthood.

It should be pointed out that until mathematicians had made formal analyses of the structure of some of these folk models, their depth and subtlety were not appreciated fully. Of the four classes of folk models distinguished above, two have received adequate formal treatment, specifically, the various mathematical theories of probability have all games of chance as models, and the various mathematical theories of games of strategy have all games of strategy as models. The formal analysis of puzzles is not in as satisfactory a state as are games of chance and games of strategy; however, we have suggested that the methods of natural deduction may help clarify the structure of puzzles.[4] When it comes to aesthetic entities, everyone is at sea and it is not known whether mathematical analyses of aesthetic objects, should such analyses prove possible, would result in only one or more than one distinct class of models. It is well to remember that until the work of von Neumann no one was in a position to make a mathematically rigorous distinction even between games of chance and games of strategy--so we should be careful about making the assumption that aesthetic objects would yield to but one overall formal theory. Regardless of this, the mathematical research into the structure of folk models has made it perfectly obvious to us that early man was not a simple-minded clod. It required inventors of genius to create these intricate objects, but even a child can begin to play with most of them. Not much in the way of technical expertise was needed to fashion the equipment used in connection with folk models: bits of wood, or stone, would do for the "pieces" used in most board games; a primitive technology was no bar to the creation of conceptually complex cultural entities.

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[4] A good simple treatment of natural deduction is contained in Fitch's text in symbolic logic (1952). Experimentation on human higher-order problem

Historically speaking, man not only invented and developed these fascinating folk models, he also devised suitable techniques for seeing to it that they were mastered by the ordinary citizen. If we think of these models as constituting the basic theoretical arm of a society's culture, then it is quite important that everyone, or virtually everyone, learns them. To put it another way, if folk models are abstract schemata which help orient us toward a wide variety of problems, then we should get them down pat. With respect to their inculcation, observe that, in general, they are learned, but not taught. What is taught are the "rules of the game," and once the rules are understood, each participant is largely on his own, except when the models are perverted by professionalism.

In every society there are social norms which distinguish between serious matters on the one hand, and fun and games on the other. Usually,

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solving which takes into consideration natural deduction is rare. However, some of our colleagues have attempted to take this into consideration, see [Carpenter, et al (1961)]. The preparation for an approach to natural deduction in terms of experimental techniques was worked out largely by Scarvia B. Anderson and Moore in a series of studies beginning in 1952 [S.B. Anderson (1955, 1956, 1957), Moore, S.B. Anderson (1954a, 1954b, 1954c)].

specific times and places are set aside for the enjoyment of folk models. Also, the stakes for winning or losing are kept at some nominal value insofar as profit and loss enter. In addition, there are norms which regulate expressions of feeling and emotion with reference to using folk models. During the course of playing with a model, one is permitted to experience a fairly wide range of feelings and emotions, but extremes are excluded. These models serve, as it were, as a school for emotional expression--this is a kind of "school" in which boredom is unlikely and uncontrolled emotional frenzy is forbidden. All in all, the set of norms governing the use of folk models, and the models themselves, have proved so successful that people have to be prohibited from playing with them too much, despite the conceptual depth of the materials with which they deal. If we think of the models as teaching devices, then they are instructional with respect to relatively universal features of man's environment--they are abstract symbolic maps of human experience. We also can see that they "teach" in ways that satisfy the following conditions:

(1) They are "cut off," in some suitable sense from the more serious sides of the society's activity, that is to say, they are cut off from immediate problems of welfare and survival. For example, if a child is learning the intricacies of social interaction the activity in which he is experiencing or practicing the interaction must allow him to make many mistakes without endangering the lives or futures of those around him, to say nothing of his own safety. Similarly, such rewards as he receives from the activity must not be too expensive to those around him, or again, the activity would have just those serious consequences which these models, as teaching devices, must avoid.

(2) But in spite of the fact that the teaching devices must avoid serious consequences, some motivation must be built into them, or else the learner may lose interest. If we rely on the distinction between activities that are intrinsically rewarding, and those that are rewarding only as a means, or extrinsically rewarding, we may say that the rewards in the learner's

activities must be intrinsic or inherent in the activity itself. We call such activities "autotelic": they contain their own goals and sources of motivation.

(3) And finally, these teaching devices, if they are to be theoretically relevant to the problems which are likely to be encountered outside the context of an autotelic environment, indeed must be models of serious activities.

Thus far we envisage a situation like this: Every society makes up abstract symbolic models of its most serious recurrent problems. Despite the complex structure of these models, everywhere they are learned with pleasure by ordinary people. Every society has social norms governing the use of its folk models and these norms have the effect of making the models autotelic, so even though the models are models of serious matters, they must be treated playfully.

The notion that materials, in the sense of the contents of everyday life, are somehow abstracted from the stream of living and reappear as the play forms of sociability is a distinctively Simmelean idea--we borrowed it from him. It is he who argues that:

> Actual forces, needs, impulses of life produce the forms of our behavior that are suitable for play. These forms, however, become independent contents and stimuli within play itself or, rather, as play. There are, for instance, the hunt; the gain by ruse; the proving of physical and intellectual strength; competition; and the dependence on chance and on the favor or powers that cannot be influenced. [Simmel (1959, p. 42)].

And he goes on to say that:

> To the person who really enjoys it [play], its attraction rather lies in the dynamics and hazards of the sociologically significant forms of activity themselves. The more profound, double sense of "social game" is that not only the game is played in a society (as its external medium) but that, with its help, people actually "play" "society," [Simmel (1959, p. 50)]

What Simmel did not do was to carry through a mathematical analysis of his cherished "play forms" of human association. He did see the need for such a formal analysis; in fact, he called for the creation of a kind of "social geometry" which would be up to characterizing the structure of play forms. He did not see that probability theory does the trick for games of chance, and, of course, the work of von Neumann on games of strategy did not come along until ten years after Simmel's death. And we all are still waiting for an intellectual giant the size of von Neumann to do a satisfactory mathematical analysis of aesthetic play forms. Nonetheless, the basic program for formal sociology, as envisaged by Simmel, is being carried out and we like to think of ourselves as helping a little.

It should be remarked that the possibilities for developing an appropriate "social geometry" are not limited to analyzing folk models. For example, normative systems are of obvious importance in interpreting human interaction. Prior to the past decade, very little had been done toward developing a mathematical analysis of such systems. It was partly in response to our sense of the need for a program of formal sociology in this area that we undertook studies in what is now called "deontic logic." This topic has been treated by a vast number of investigators since von Wright's seminal essay of 1951, and the improvement in our own understanding of the basic ideas involved can be seen by comparing the analysis we offered in 1957 [Anderson, Moore (1957)] with a 1967 version [Anderson (1967)].[5]

Another problem area which has significance for formal sociology is the mathematical treatment of the notion of relevance. Human affairs are conducted within universes of discourse in which some standards of relevance are presupposed, but the study of "relevant implication" was a neglected area in mathematical logic, so efforts were made to create the required formal machinery.[6] Interestingly enough, the improvement in our understanding of problems in deontic logic came about mainly because of this apparently unrelated work on the logic of relevance. This was one of those "unexpected" bonuses which we come to "expect" from what seems, on the surface, to be merely remote abstract considerations.

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[5] Though the interest in deontic logic is our common concern, most of the relevant work under this project has been done by A.R. Anderson. See (1956a, 1956b, 1958a, 1958b, 1959, 1962). For a reference to von Wright's essay, and a reasonably complete bibliography as of 1966, see the reprinted version of A.R. Anderson (1956a).

Another area of investigation should be mentioned which also fits into the program of "formal" sociology. It turned out that there were almost no mathematical analyses of the logical structure of questions and answers. Yet surely here, if anywhere, is a distinctively human preoccupation, namely, the asking and answering of questions. The form treatment of questions and answers is called "erotetic logic," a term introduced in 1955 by Mary and Arthur Prior (1955). It is being pursued by our colleague, Nuel D. Belnap, Jr. (among others), whose An Analysis of Questions (1963) provides a substantial treatment of this topic with bibliographic references.

Personality

Turning now from folk models qua cultural objects to some of their implications for personality, there is another possibility with reference to them that Simmel did not pursue. If our folk models and his play forms have the theoretical importance we attribute to them, then they should be of help in analyzing the structure of human personality. We have given some thought to this matter and our considerations have led us in the direction of the work of George Herbert Mead. As a heuristic gamble, we were willing to assume that the major functional components of human personality, and the organization of these components, reflect the structure of the folk models. By taking this view of human personality, we were led to ask whether each of the four kinds of folk models corresponds to a characteristic attitude or perspective that a person might take toward his world.

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[6] Again, the logic of relevant inference and entailment is of common concern. In this case the work has been done by Anderson and Belnap [Anderson (1957, 1960, 1963), Anderson, Belnap (1958, 1959a, 1959b, 1959c, 1961a, 1961b, 1961c, 1963), Anderson, Belnap, Wallace (1960), Belnap (1959a, 1959b, 1960a, 1960b, 1960c, 1960d, 1967), Belnap, Wallace (1961)], building their work on an important paper of Ackerman (1956).

It is our thesis that each class of models does so correspond, and that the models build upon one another in a particular order.

In capsule form, our position is:

(1) Puzzles emphasize a sense of agency. We call this the "agent perspective." This is the outlook that perhaps Cooley (1902) had in mind when he spoke of "the joy of being a cause."

(2) Games of chance emphasize a sense of patienthood, i.e., being the recipient of consequences over which we have virtually no control. We call this the "patient perspective."

(3) Games of strategy presuppose an agent-patient perspective, but emphasize what we call the "reciprocal perspective." In Meadean terminology, this would seem to be the perspective of a "significant other." For example, in playing bridge there is room for meaningful acts of agency and we are sometimes patient to all manner of outrageous happenings, some due to chance, some due to our opponent, some due to our partner, and even a few of our own doing. But the heart of the game (as von Neumann showed with beautiful precision) lies in the possible interrelations between the two opposing teams, each of which must take the other into account. This means that a genuine game of strategy, such as bridge, does not reduce mathematically into either the form of a puzzle or the form of a game of chance. This means, also, that a person who is looking at the world from the standpoint of the reciprocal perspective does not see another human being as merely puzzling or unpredictable, but rather he sees him as someone who is capable of looking at him as he looks at the other.

(4) Aesthetic entities emphasize a sense of assessing, evaluating or judging. This perspective presupposes significant others in interaction, i.e., it presupposes entities that behave in terms of the other three perspectives. We call this judgmental stance the "referee's perspective." The point of view of a judge in a bridge tournament (or any given player when he looks at his own play or the play of others as if he were the judge) is not that of any player *qua* player, nor is it some sort of average or consensus of the players' viewpoints. The referee's concern ranges over the whole game--his viewpoint presupposes that there

are players with their reciprocal perspectives. With reference to Mead's analysis of personality, we think that the concept of the referee's perspective is a plausible explication of his concept of the "generalized other."

We made this point in connection with the reciprocal perspective that it did not collapse, logically speaking, into either of the two perspectives upon which it builds, namely, the agent and the patient perspectives. The reason we said this is that the mathematical structure of games of strategy is not reducible to either puzzles or games of chance. We want to make a similar argument now about the referee's perspective--it does not reduce to or collapse into any or all of the other three perspectives. Our reason for being confident about this is that the mathematics of the referee's perspective, insofar as it is deontic or normative, does not reduce to ordinary extensional logic, nor to the logic of possibility, nor to the logic of probability. The referee's perspective is a logically distinct realm. We realize that not everyone would find this line of reasoning convincing--and perhaps it should not be relied on too heavily--but we remember that not long ago there were those who thought it very unlikely that deontic logic could be set up on a solid footing, namely, on a basis which would not immediately collapse into the standard extensional systems.

A human being who has been socialized in the sense of Mead, i.e., an individual who has acquired a social self, should be able to take any of the four perspectives mentioned above. What is more, he should be able to handle them one by one, in pairs, in triples and in one superordinate quadruple--depending, of course, on the nature of the problem with which he is confronted. We say that his social self is constituted, in part, by the organization of these perspectives. A social self is neither something that anyone is born with, nor does it come about automatically through the processes of physiological maturation; rather, it is an achievement in learning which we think is guided in part by autotelic folk models.

We agree with the general Meadean analysis about how the social self, as an organization of perspectives, emerges out of a matrix of social processes--and how it, in turn, may affect these same processes. We appreciate particularly the suggestions Mead makes concerning the process whereby the interplay among human beings begins with a "conversation of gestures" and leads on to symbolic interaction. This interaction takes place through the use of "significant symbols"--these symbols being defined in terms of a common universe of discourse. This universe of discourse, in turn, gains its relevance by virtue of its systematic relations to the set of social processes out of which the social interaction arises. For us, among the most significant of what Mead calls "significant symbols" are the symbolic complexes which we have dubbed "folk models." Of course, natural languages as systems of significant symbols are of prime importance, too. We agree completely with Mead about this.

Mead was well aware of the importance of play and of games as part of the process whereby a social self is acquired. In fact, he made a distinction between playing and taking part in a game to drive home his point that the development of the human personality takes place in a series of interrelated phases. A young child may _play_ in the sense of taking the role of a series of significant others, but until he grasps the structure of the rules which make a game a game--that is until he can govern his ongoing conduct in the light of what we call the referee's perspective, or in Mead's terminology, the "generalized other"--the child is only _playing_ and not _gaming_. And, to the extent that he is not up to handling games, he is only partially socialized. Clearly, it is compatible with the Meadean position to assume that conduct which flows from a mature social self would involve the use of each of the perspectives in the solution of challenging problems. It is convenient to think of each perspective as a part of the social self. As has been made clear above, we think that there are at least four such parts of a socialized human being: agent, patient, reciprocator, and referee.

Information Processing

Any problem worthy of the full talents of an adult human being requires that he carry out a great deal of information processing with respect to it. Obviously, this information processing is subject to some kind of control. The question is "What kind?" In terms of an engineering analysis, there are two major kinds of control systems that we can consider: those of the open-loop variety and those of the closed-loop variety.

An open-loop control system is one which exercises its control in a way that is independent of the output of the system. Open-loop systems, generally speaking, are not bothered by problems of instability.

A closed-loop control system is one in which the control is somehow dependent upon the system's output (or some symbolic representation of that output).

Closed-loop systems tend to suffer from various forms of instability. As was remarked before, human beings must have some sort of a control system to govern their information processing. Judging from the tendency of human beings to become unstable, we guess that the human control system is of the closed-loop variety. As a matter of fact, we assume a great deal more than that--we posit that the four perspectives constitute a subsystem which functions as part of an overall control system governing information processing.

It may seem to some that our brief discussion above about control systems is very remote from a Meadean analysis. We do not think that this is the case at all. Mead attempted to formulate a number of ideas which, in retrospect, can be recognized as brilliant anticipations of concepts which later received explicit treatment along the lines that he suggested. The Meadean notion of an attitude or perspective is a case in point. Let us listen to Mead a bit as he tried to tell his students and colleagues what he meant by an attitude.

> Present results, however, suggest the organization of the act in terms of attitudes. There is an organization of the various parts of the nervous system that are going to be responsible for acts, an organization which represents not only that which is immediately taking place, but also the later stages that are to take place. If one approaches a distant object he approaches it with reference to what he is going to do when he arrives there. If one is approaching a hammer he is muscularly all ready to seize the handle

> of the hammer. The later stages of the act are present in the early stages--not simply in the sense that they are all ready to go off, but in the sense that they serve to control the process itself. They determine how we are going to approach the object, and the steps in our early manipulation of it. We can recognize, then, that the innervation of certain groups of cells in the central nervous system can already initiate in advance the later stages of the act. The act as a whole can be there determining the process. [Mead (1934, p. 11)]

When Mead advanced this analysis of an attitude, his remarks were interpreted by many to be sheer teleological nonsense. Now we understand these ideas much better--he is saying that ongoing human activity is subject to a closed-loop control system. No contemporary engineer would regard this as metaphysics (in the ba-a-ad sense).[7]

Information Processing for Human Beings

We posit a control system which governs information processing that is sufficiently reflexive to allow a human being to stand back from himself in order to view himself as an object. What is more, this control system must allow him to see himself from the standpoint of any of the perspectives while he is planning or executing actions. This hypothetical control system must make provision for the fact that we can and do soliloquize. It must both permit and control internal dialogues such as: "I would like to do X, but I am not sure that it would make me happy. My father approves, but he doesn't understand. My mother doesn't approve and she does understand. It's illegal, but my friends say it is good." We all go round and round like this, looking at the world in terms of what we can do, what might happen to us, what our friends and enemies think, and what the referee might say. Sometimes these considerations get out of hand and we become bogged down in repetitious and viciously circular chains of reasoning. Sometimes we fail to consider a problem from some important perspective.

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[7] We are well aware that "metaphysics" has an honorific sense, stemming from Aristotle's attempt to figure out how the Universe ticks, and a pejorative sense, stemming from the logical empiricist rejection of Theology and its sister-disciplines (e.g., Mariology). A good bit of what we are trying to convey in this article is probably metaphysics, in what we hope is a "good" sense.

The upshot is: we assume that a fully socialized human being, in a state of good emotional health, would have a control system which permits him to consider himself in a reflexive way from the standpoints which are represented abstractly in cultural terms by the four autotelic folk models.

Order of Mastering Perspectives

If the social self consists in part, at least, of an organization of perspectives, and if these perspectives are learned, then the question can be raised as to whether they are acquired in some particular order. Is the socialization process some sort of ordered sequence? We believe so and our analysis of human developmental phases follows our interpretation of Mead quite closely. We assume that the agent and patient perspectives are the first to develop--they are "twin born" to use Mead's expression. The notion of an agent is linked to that of a patient--but it may take an infant some time to discover that this is so; there are indeed studies which indicate that it takes a while for new-born infants to begin to understand the difference between their own bodies and their environment. But even if the agent-patient pair are twin-born, we still think of this pair as one term in a relation with the reciprocal perspective. Finally, the complete development of personality involves the pair-wise combination of the complex term agent-patient-reciprocal with the referee perspective. As was remarked earlier, the building up of this system into its most complex form does not mean that all parts need be involved in the solution of all problems; the system is sufficiently flexible, if its development goes well, so that the "parts" can be used one at a time, or in various combinations. As one can see, this is a fairly complex system even without further complications; there are some, on which we would now like to comment.

Complications Concerning Kind-Heartedness

Up to the present point, this summary of our position about human personality has made only passing reference to feeling and emotion. Are we to imagine that human beings are engaged mainly in the processing of information *sans* an involvement with affect? This would be an odd view of human nature, though the Meadean system tends to be odd in just this way. Mead had little to say about feeling and emotion. At the very least, we believe that it is essential to posit a *system* of feeling and emotion, and to make some assumptions about this system. This obviously is a complex topic. Here we will mention only a few of our assumptions--some which will help us later in the task of formulating principles for designing educational environments.

(1) Each perspective is directly connected to the system of feeling and emotion so that the control system gets a "reading" from the system of feeling and emotion about reactions to plans and the execution of plans, or, more generally, about ongoing activity. This means that we can have, but need not have, "mixed feelings and emotions." For example, a mountaineer, in thinking about rappelling down a cliff, may feel elation as an agent, anxiety as a patient, shame at the possibility of showing fear, and guilt for rappelling at all since he is a family man and knows he should not take such risks--his own (kind-hearted) referee perspective says he is out of bounds.

(2) The system of feeling and emotion is so organized that, under some circumstances, at least, it is possible to change the scale of feeling and emotion without necessarily altering its relative proportions. For example, in playing a game of chess, we can run through a wide gamut of emotions in, as it were, "attenuated" form--we can experience token amounts of anxiety, fear, etc., without literally panicking. Of course, the system of feeling and emotion may get out of control as in some kinds of mental illness--the scale of intensity may be shifted in the direction of gross exaggeration, on the one hand, or flatness of affect, on the other.

(3) We not only have feelings and emotions, but each individual, in a reflexive way, can learn about his own

reactions. The possibility of gaining some reasonable self-control with respect to affect, depends upon learning to recognize, differentiate and generalize about this vital aspect of ourselves; in other words, feeling and emotion can be schooled--and the use of autotelic folk models is normally part of this educational process.

Interlude

Someone who has followed the heuristic ideas presented above about human culture and the socialization process might be tempted to ask the following question: "If you regard these autotelic folk models so highly as guides to action, if they, indeed, represent abstractly so many salient features of human existence, and if they provide a basis for the structure of human personality, then do we need scientific models as opposed to folk models?" Our answer is that we do need scientific models. Folk models have served man well during most of his history, but there is something radically wrong with them with respect to their present theoretical relevance--something has happened which has rendered them worse than obsolete.

So long as the ordinary man lived out his life within the context of a static social framework, these models matched his world; the models themselves are essentially static entities. For instance, in any play of the game of chess, the rules--that is, the boundary conditions--remain constant. There may be plenty of lively action going on within this stable frame of reference and the participants may feel a wide range of emotions, but the rules are both fixed and inviolable in a normative sense. If you are working a puzzle, say a jigsaw puzzle, the picture to be completed does not change as you work on the puzzle, and the pieces preserve constancy of size and shape. If you go to see a play two nights in a row, it remains the same play with trivial variations; the actors do not change their lines because you have seen it before, though you may appreciate it more thoroughly on seeing it the second time. The basic point we are attempting to make is that folk models mirror the static quality of unchanging or imperceptibly changing societies. The folk models in this respect are like the Newtonian conceptions of space and time--both presuppose a frame of reference which is invariant with respect to all that goes on within it.

Today we live in a new world, a world in acceleration, a dynamic fluid world. In the 1940's the major industrial societies underwent a massive acceleration in technological development. This increase in the rate of technological change was so large, as far as its social consequences are concerned, as to amount to a difference in kind rather than one of degree.[8] Because of this, we, along with many others, have come to divide technological history into two main periods--the primitive, from the dawn of human history to the 1940's, and the modern, from the 1940's on. In order to make this case we draw graphs of technological functions, plotting, on a time scale of 10,000 years, such things as the speed of travel, the force of explosives, the size of objects which can be manipulated with precision, the number of people who can be included simultaneously within one communication network. The curves for these and many other technological functions bend sharply upward at about this time and they are now heading off the graph. Of course, there are some who are unhappy with the notion of pinpointing this acceleration in the decade of the 40's. They prefer to think in terms of a series of accelerations, each jolt larger than its predecessor. The time span for this series is taken to be the first half of the 20th century. In any case we agree with those who see a radical change.

Many aspects of this radical change in technological capability have become matters of grave concern. For example, most reasonably well-informed people understand that because the first fission device multiplied the explosive force of previous weapons a thousandfold, and a few years later a fusion device multiplied explosive force a million times, mankind now is in a position to do something it could never do before--to wit, it can commit suicide. All of this boggles the mind, but the aspect of the matter to which we want to draw attention here is the significance of the new technology for the socialization process.

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[8] We yield to none in insisting on our inability to make the difference between "kind" and "degree" clear, and this is not the place to try to go into the matter. But it does seem apparent that the difference between two chicken eggs of a slightly different size is a difference of degree, whereas the differences between either of the two eggs or a behemoth is of rather more startling proportions; the latter we think of as a difference in kind.

We think that one important result of this technological leap is that we are in transition from what we have called a "performance" society to a "learning" society. In a performance society it is reasonable to assume that one will practice in adulthood skills which were acquired in youth. That, of course, has been the traditional educational pattern for human beings, and it is reflected in our linguistic conventions. We say that a medical student, for instance, learns medicine and the doctor _practices_ it. There is also the _practice_ of law, and, in general, adults have been the _practitioners_ of the skills which they learned as apprentices. In contrast, in a learning society, it is not reasonable to assume that one will practice in adulthood the skills which were acquired as a youth. Instead, we can expect to have several distinct careers within the course of one lifetime. Or, if we stay within one occupational field, it can be taken for granted that it will be fundamentally transformed several times. In a learning society, education is a continuing process--learning must go on and on and on. Anyone who either stops or is somehow prevented from further learning is reduced thereby to the status of an impotent bystander.

We assume that the shift from a _performance_ to a _learning_ society calls for a thoroughgoing transformation of our educational institutions--their administration, their curricula, and their methods of instruction. Education must give priority to the acquisition of a flexible set of highly abstract conceptual tools. An appropriate theoretical apparatus would range not only over the physical and biological sciences, but over the subject matter of the behavioral and social sciences as well. What is required is the inculcation of a deep, dynamic, conceptual grasp of fundamental matters--mere technical virtuosity within a fixed frame of reference is not only insufficient, but it can be a positive barrier to growth. Only symbolic skills of the highest abstractness, the greatest generality, are of utility in coping with radical change. This brings us back to the folk models which are inculcated in childhood. If they "teach" a conception of the world which is incompatible with a civilization in acceleration, then we have the challenge of creating new models appropriate for these changed and changing circumstances--we need models that are fundamentally dynamic.

In the next section of this paper we will present some very general principles for designing educational environments. It will be apparent at once that we have tried to learn some lessons from the thousands of years of human experience with autotelic folk models, but as was indicated above, we do not think that it is wise to be bound to them in any exclusive sense. The usual kinds of autotelic folk models could get along very nicely with sticks and stones on their physical side; however dynamic models for a learning society seem to require the imaginative use of a much more subtle technology.

Principles for Designing Clarifying Environments[9]

Our task now is to state and explain a set of four principles for designing educational environments. Any environment which satisfies all four of these principles will be said to be a "clarifying environment."

It will be seen that the first three principles to be treated are directly related to the notion of a folk model. The fourth principle seeks to make provision for the fact that we live in a world undergoing dynamic change.

> (1) Perspectives Principle. One environment is more conducive to learning than another if it both permits and facilitates the taking of more perspectives toward whatever is to be learned.

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[9] It should be made clear that though this paper is in a certain sense a joint venture, the experimental and sociological part of the work belongs entirely to Moore. There is no particular point in trying to disentangle our contributions to what goes on here, beyond noting that the present paper represents the results, some of which have been reported elsewhere, of about ten years of collaboration. Formulation and application of the principles to follow are the results of Moore's work.

(2) Autotelic Principle. One environment is more conducive to learning than another if the activities carried on within it are more autotelic.

(3) Productive Principle. One environment is more conducive to learning than another if what is to be learned within it is more productive.

(4) Personalization Principle. One environment is more conducive to learning than another if it: (1) is more responsive to the learner's activities, and (2) permits and facilitates the learner's taking a more reflexive view of himself as a learner.

The statement of the foregoing four[10] principles is sufficiently cryptic to make even a phrenologist happy. In spite of this fact, we believe they make some sense; and we forthwith proceed to try to explain the sense we think they make.

Perspectives Principle

The perspectives to which this principle refer are, of course, the four discussed in the previous section, namely, agent, patient, reciprocator and referee. This principle assumes, *ceteris paribus*, that learning is more rapid and deeper if the learner can approach whatever is to be learned:

(a) from all four of the perspectives rather than from just three, from three rather than from just two, and from two rather than from only one and

(b) in all combinations of these perspectives--hence, an environment that permits and facilitates fewer combinations is weaker from a learning standpoint than one that makes provision for more combination.

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[10] C.S. Pierce observed somewhere that he had a "certain partiality for the number *three* in philosophy." From what follows, the reader will observe that *we* have a partiality to its successor. On the other hand, even Peirce occasionally gave way to *four* (1868).

Another aspect of environmental flexibility with respect to the assumption of perspectives has to do with the attitude the learner brings to the environment each time he enters it. Imagine a learner who, one day, if filled with a sense of agency--he is in no mood, for instance, to be patient to anything or anybody. An environment will be more powerful from a learning standpoint if it lets him start off with whatever perspective he brings to it, and then allows him to shift at will.

As a parenthetical remark about shifting from one perspective to another, we think that young children do not have what is sometimes called a short "attention span," but they do have a relatively short and unstable "perspective span." This is one reason why there is little use in trying to deliver a lecture to a young child--he is not up to assuming the stance of a patient for very long at a time. But he can stay with the same topic or subject matter if he is permitted to run through a rather wide range of perspectives in whatever order he pleases.

When experts in education maintain that formal schooling is unsuitable for the very young child, the use of the word "formal" denotes the typical classroom situation in which most acts of agency are allocated to the teacher, the referee's role is also assigned primarily to the teacher, and the assumption of the reciprocal perspective in the form of interacting with peer-group members is forbidden through rules which are against note passing and which impose silence. About all that is left to the child is to be patient to the acts of agency of the teacher. This undoubtedly is an unsuitable learning situation for most young children--and the perspectives principle says that it is not as conducive to learning as a wide variety of alternative arrangements.

Another way to get the flavor of the perspectives principle is to pose the question as to why amusement parks amuse the young, but pall so rapidly. Think about the merry-go-round, the roller coaster, the fun-house with its surprises, etc.--it is apparent that what all of these "amusements" have in common is the rapid, involuntary shift in viewpoint within the context of one basic perspective, specifically, each exploits some facet of patienthood. Any environment which tends to confine people to one basic perspective is apt to become boring rather quickly. Of course, the symbolic level of amusement-park entertainment is relatively low, too, although it is high in its appeal to simple feelings and emotions. Consequently, a few trips to an amusement park go a long way.

Clearly, the theater is a more subtle form of entertainment; with it the shifts in perspectives are largely symbolic in character, rather than grossly physical. However, like the amusement park, the theater shares a weakness. Both force us to be spectators--patient to what goes on. An amusement-park ride hauls us through a predetermined course without any opportunity for changes due to our own acts of agency; similarly, plays run their predetermined courses. Though the patient perspective is salient at the amusement park and the theater, the referee's stance comes into the picture, too, as we assess and evaluate what goes on. There is also the vicarious opportunity to place ourselves in the roles of others, as, for instance, when we witness the screams and squirmings of others on a roller-coaster ride.

It should be noted that these and related forms of amusement are changing. Recent innovations in motion pictures permit the audience to vote from time to time on how they want things to come out. This is a step, though a crude one, in allowing for the agent perspective in entertainment. Some new amusement-park rides give a few controls to the passengers. Also, turning our attention for the moment to "cultural" entertainment, the traditional museum seems to be on its way out--more and more displays are subject to some sort of control by the visitor. So, we see the amusement park, the theater (at least motion pictures), and the museum moving away from the boredom inherent in a confining perspective. They are coming closer to satisfying the perspectives principle, which (to repeat) says that "one environment is more conducive to learning than another if it both permits and facilitates the taking of more perspectives toward whatever is to be learned."

Autotelic Principle

For an environment to be autotelic it must protect its denizens against serious consequences so that the goings on within it can be enjoyed for their own sake. The most obvious form of protection is physical. There are sports which come perilously close to violating their own autotelic norms because of physical risks--mountaineering is one. When a mountaineer is asked why he climbs, the fact that this question arose indicates something is amiss. People do not go about asking bowlers, chess players, and tennis players, to take one mixed bag of players, for deep reasons to justify their activities. Mountaineers, like racing-car drivers, are always trying to prove that their sport only appears to be dangerous--they argue that it is not hazardous for those who are properly trained.

When it comes to designing educational environments, especially those concerned with the acquisition of intellectual skills, almost everyone is pretty well agreed to keep physical risk out. True, there are some advocates of corporal punishment; and we should remember that there is the occasional fanatic, such as a teacher we once knew who thought that the only way to do mathematics was in an ice cold room. He began each class by throwing open the windows, even on bitterly cold days, which gave a kind of chilly introduction to algebra.

It is relatively easy to keep physical risks out of educational environments though there may always be the school-yard bully who punishes the scholar for his scholarship, and today, big-city schools increasingly require policemen to maintain order. Even so, it is more difficult to keep psychological and social risks out of an educational environment. If a student feels, while taking an exam, that he may disgrace himself and blight his future by failing to make a mark high enough to get into some special program, or if he feels that learning is simply a means of staying on a gravy train with stops only for prizes, honors, and scholarships on the way to success, then the whole learning environment is shot through with high psychological and social risks. For a learning environment to be autotelic, it must be cut off from just such risks.

Granted the nature of our present public and private school systems, and their relation to the broader society, it is doubtful that, at this time, more than a small fraction of the school day could be made autotelic. As a matter of fact, it is very difficult to arrange matters so that even a preschool child can have as much as thirty minutes a day that is really his, in the sense that none of the significant adults in his life is in a position to manipulate him, and where the things to be learned in the environment have a chance to speak persuasively to him in their own tongue.

Most contemporary education is nonautotelic; in fact, it prides itself on its nonautotelic status--school counselors carefully explain the financial and social rewards of further schooling. Through public service announcements, officials plead with dropouts to come back, and again, the basic argument given for returning to school is for rewards--financial and social. We never have hears a public service announcement which said something like, "Come back to school. Algebra is better than ever!"

The school day is so crammed full of activities that are planned to lead directly to the goal of at least one college degree, that a student seldom has the leisure to follow out the implications of an interesting problem, should he have the social misfortune of becoming intrigued by something truly puzzling. If a highly competent student works very hard, he may win a little extra time in which he can entertain a few ideas without having to cash them in at a science fair or some other parody of independent thinking.

Not only is the educational system largely nonautotelic in character, but the traditional folk models are in danger of being swept away. Little-league baseball replaces vacant-lot baseball. Amateur athletics in general seem to be turning into quasi-professional activities. On the more intellectual side our puzzles have been incorporated into the structure of tests--all current tests of ability are really a series of short puzzles.

Regardless of all of this, the autotelic principle states that the best way to learn really difficult things is to be placed in an environment in which you can try things out, make a fool of yourself, guess outrageously, or play it close to the vest--all without serious consequences. The autotelic principle does not say that once the difficult task of acquiring a complex symbolic skill is well underway, it is then not appropriate to test yourself in a wide variety of serious competitions. It is a common misunderstanding of the notion of an autotelic environment to assume that all activities should be made autotelic. Not so. The whole distinction requires a difference between a time for playfulness and a time for earnest efforts with real risks.

Productive Principle

Our statement of the productive principle is enigmatic at this point because we have not yet clarified the term "productive" though we have made implicit use of the concept of "productivity," in our prior disucssion of folk models. So let us be explicit now.

We will say that one cultural object (a cultural object is something that is socially transmissible through learning) is more productive than another cultural object if it has properties which permit the learner either to deduce things about it, granted a partial presentation of it in the first instance, or make probably inferences [Peirce anthology (1955)] about it, again assuming only a partial exposure to it.

Some examples may help. A perfect instance of a productive cultural object is a mathematical system. We can give the learner some axioms, some formation and transformation rules, and then he is at liberty to deduce theorems on his own. The logical structure of the system is what makes it productive. However, we are not always in a position to deal with such beautifully articulated structures. A case in point is the periodic table of elements. Its structure is productive on the basis of probable inference as opposed to deductive inference. Our evidence for productivity in this case is that empty cells in the table have been filled in with elements having the predicted properties. But compare the periodic table with an alphabetical arrangement of the same elements. The latter is less productive than the former by a country mile. In order to be more precise about all of this we would need a general theory of "probable inference" as well as a theory of "deducibility." We hope that a crude characterization of productiveness will be sufficient for our present purposes.

Turning back to the principle itself, it says, again _ceteris paribus_, that of two versions of something to be learned, we should choose the one which is most productive; this frees the learner to reason things out for himself and it also frees him from depending upon authority.[11]

Folk models, taken collectively, are good examples of productive cultural objects. To illustrate, once the simple rules for playing chess are mastered, it is not necessary to consult anyone in order to go on playing chess. It is true that one may be playing badly, but the structure of the rules for playing are sufficiently productive to guarantee that it is bad chess and not bad checkers that is being played.

Now that we have cleared things up a bit, someone might wonder why anyone would bother to state the productive principle as a principle for designing educational environments. Surely, people would not select the less productive of two versions of something to be learned. Yes, they would! The example above concerning the periodic table did not just pop into our heads. We observed, not long ago, a science teacher who had his students learn the atomic numbers and the atomic weights of the elements in _alphabetic order_. This is a tough task, and only a few of the children could manage it. Doubtless, you say, this is a rare aberration. Again, we beg to disagree. Let us take, as our case in point, the teaching of reading in the United States.

As everyone knows, or is supposed to know, there are two contrasting kinds of orthographic systems. On the one hand, there is the ideographic sort in which knowing some "words" gives almost no clues as to how to handle the next written word. The Chinese system of writing is of this kind; it is barely productive at all.[12] On the other hand, there are many systems of writing which are alphabetic. Once the learner has cracked the code which relates the written and spoken versions of the language to each other, he can write anything he can say, or he can read anything that has been written. (The only things sacrificed by not referring to authority are the niceties of spelling and punctuation, but the phonetics carry the meaning.) Such alphabetic systems of writing are productive cultural objects, even, we should point out, in the case of a child of our acquaintance who spelled the word for eyes as "is." Given our usual spelling habits, this looks at best like an imaginative leap at an attempt to spell "eyes," but as Moore has pointed out elsewhere (1963), English orthography has more coherence than it is given credit for. However, many of the standard textbooks for teaching beginning reading used in our country today treat written English as if it were Chinese.

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[11] Though we do not know exactly how to characterize "productivity," we can give at least one clear example. The "natural deduction" methods of Gentzen, Jaskowski, Fitch [see Fitch (1952) for references], and others are "productive" in that they help the student figure out what is going on. By contrast Nicod's single axiom for the propositional calculus prompted Irving Copi to quote Dr. Johnson's alleged remark about a woman preaching: it is "...like a dog's walking on his hind legs. It is not done well; but you are surprised to find it done at all."

Personalization Principle

This principle, unlike the others, has two distinct parts: the idea is that the environment must be both (1) responsive to the learner's activities and (2) helpful in letting him learn to take a reflexive view of himself. The explanation comes in two pieces.

(1) The *responsive* condition. The notion of a responsive environment is a complex one, but the intuitive idea is straightforward enough. It is the antithesis of an environment that answers a question that was never asked,[13] or, positively stated, it is an environment that encourages

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[12] There is some *slight* productivity in the fact that such characters as those for *tree*, *grove*, and *forest* have a reasonable connection: a tree looks like 木, a grove like 木木, and a forest like 森. Similarly the character 口 means (among other things) *mouth*, *entrance*, *opening*, *hole*. But whoever would have guessed that 龜 meant "turtle"?

[13] We are all familiar with situations where we are given information we did not want to have. Our earlier discussion indicates our belief that many school children are in this situation (as we both were), and we suppose that the adult analogue is wading through all that dreary stuff about soap, while waiting for the eleven o'clock news on TV.

the learner first to find a question, then find an answer. The requirements imposed upon an environment in order to qualify it as "responsive" are:

(a) It permits the learner to explore freely, thus giving him a chance to discover a problem.

(b) It informs the learner immediately about the consequences of his actions. (How immediate is immediate will be discussed later.)

(c) It is self-pacing, i.e., events happen within the environment at a rate largely determined by the learner. (The notion that the rate is largely determined by the learner and not wholly determined by him is important. For example, some hyperactive children rush at their problems so much that the consequences of their actions are blurred--there must be provision for slowing down the learner under some circumstances; also, there are occasions when he should be speeded up. Nonetheless, it is basically self-pacing.)

(d) It permits the learner to make full use of his capacity for discovering relations of various kinds. (No one knows what anyone's full capacity for making discoveries is, but if we hand the learner a solution we certainly know we are not drawing upon his capacity.)

(e) It is so structured that the learner is likely to make a series of interconnected discoveries about the physical, cultural or social world. (What this amounts to depends, of course, upon what kinds of relations are being "taught" within the environment.)

The conditions for responsiveness taken together define a situation in which a premium is placed on the making of fresh deductions and inductions, as opposed to having things explained didactically. It encourages the learner to ask questions, and the environment will respond in relevant ways; but these ways may not always be simple or predictable. For a learner to make discoveries, there must be some gaps or discontinuities in his experience that he feels he must bridge. One way that such discontinuities can be built into a responsive environment is to make provision for changing the "rules of the game" without the learner knowing, at first, that they have been changed. However, it will not do to change the rules quixotically--the new set of rules should build upon the old, displacing them only in part. Such changes allow the learner to discover that something has gone wrong--old solutions will no longer do--he must change in order to cope with change. In other words, if you want a learner to make a series of interconnected discoveries, you will have to see to it that he encounters difficulties that are problematic for him. When he reaches a solution, at least part of that solution should be transferable to the solution of the next perplexity.

Finally, though a responsive environment does respond, its response has an integrity of its own. It is incorrect to think of a responsive environment as one which simply yeilds to whatever the learner wants to do--there are constraints. To take a trivial example, if the question is how to spell the word "cat," the environment permits the learner to attempt to spell it K-A-T--there is no rule against trying this, but he will not succeed that way, where by "succeeding," we mean both getting a satisfactory response from the environment, and learning the sort of thing the environment was devised to help him learn. Without the latter condition the environment would not be informative.

(2) The reflexive condition. One environment is more reflexive than another if it makes it easier for the learner to see himself as a social object. We previously made the point, the Meadean point, that the acquisition of the social self is an achievement in learning. Unfortunately, some of us are underachievers. One reason, we think, for our ineptitude in fashioning ourselves is that it is hard to see what we are doing--we lack an appropriate mirror. The reflexiveness which is characteristic of maturity is sometimes so late in coming that we are unable to make major alterations in ourselves. "The reflexive condition" is fairly heavy terminology; all we mean is that if an environment is so structured that the learner not only can learn whatever is to be learned, but also can learn about himself qua learner, he will be in a better position to undertake whatever task comes next. It facilitates future learning to see our own learning career both retrospectively and prospectively. It is a normal thing for human beings to make up hypotheses about themselves, and it is important that these hypotheses do not harden into dogma on the basis of grossly inadequate information.

We find it not at all surprising that athletic coaches have made more use of reflexive devices in instruction than have classroom teachers. This does not surprise us because of our confidence in play forms. It is in the realm of sports that motion pictures of learning and practice have come into wide usage. Coaches go over games with their players, spotting weaknesses, strengths, etc.--they do not forget their opponents, either. Of course, motion pictures used reflexively have limitations, but surely coaches have taken a step in the right direction.

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The four principles presented above, perspectives, autotelic, productive and personalization, are offered as heuristic guides[14] for constructing educational environments. Undoubtedly, they are vague and ambiguous; the critical question is whether they are so deficient as to be useless. We do not think that they are totally without merit. In the next section we offer an application of the principles to show what can be made of them.

An Application of the Four Principles

Imagine that for some unaccountable reason you were given the problem of designing an educational environment for preschool children. Imagine also that this environment is to be one in which the children learn to read their natural language. What would you do?

One of us has taken upon himself the task of building several such environments, beginning with the very simple, and gradually working up to larger, more complex ones. This evolution of environments was marked by a gradual increase in the sophistication of the technology which went into them. The four principles we have discussed were used in designing both the overall structure of these environments and the technology used within them. We would like to make it clear, incidentally, as a methodological point, that the ideas came first, and the applications (both in logic and behavioral science) came afterwards. However, our understanding of the principles and the clarity with which we saw their relevance increased with the experience of actually constructing learning environments.

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[14] Some people might prefer that we convert the principles into empirical propositions and then proceed to test their truth. We would caution that they would require a much more rigorous formulation if they were to be treated as anything more than heuristic guidelines. The difficulty in such reformulations is that the principles make use of a number of concepts which are not very well understood mathematically. So, for the moment, let us take them as guides, and only as such.

Let us go over each principle to see what it "tells" us to do.

Perspectives Principle--Application

If the children who come to the environment are to learn to read, we should ask what sort of an activity reading is. In the simplest terms, reading involves the decoding of a message which was previously encoded.[15] Leaving aside the special case where the reader decodes his own material, as a reader we are patient to the symbolic consequences of someone else's activity. We read what the writer wrote. This is banal, all right, but it does point to a one-sided emphasis in reading that the principle seeks to avoid. Is there some way to allow the learner to stand in the relation of agent as well as patient to reading material?

First, the perspectives principle urges that we think about this. An answer comes readily. Reading should be treated as part of a correlative process. Specifically, the decoding and encoding of messages, that is, reading and writing, should be developed together. Reading emphasizes patienthood and writing emphasizes agency. Once one begins to look around for correlative processes which give the learner an opportunity to take more perspectives toward his task, other combinations come easily to mind. For instance, what about listening and speaking? Obviously, listening stands to reading as writing stands to speaking. The first pair, reading and listening, is on the side of patienthood, the other is on the side of agency.

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[15] Here we are simply going to bypass the usual hornet's nest of questions about the logical and ontological status of "information" about "type-token" distinctions and the like. We will also fail to discuss the question as to whether speech is encoded writing, or writing is encoded speech. Not that these are unimportant issues, but this is not the place to discuss them.

Thus we are being led by the perspectives principle to widen our definition of the learner's task. Originally, we thought of him as learning to read, now we see him as learning to handle a four-fold set of linguistic processes: reading, writing, listening, speaking. With regard to this set, the learner's redefined task is to communicate more effectively rather than simply to read.

Up to this point we have drawn on only two of the four basic perspectives, agent and patient, but the reciprocal perspective suggests something else. As will be recalled, to take the reciprocal perspective is to look at our own behavior from the standpoint of someone else. What implications does this have for reading?

If we are reading something, we may want to know who wrote it. We may wish to understand the context out of which the message comes. It would seem that we should begin to learn very early to distinguish among various sources of messages if we are to put ourselves in the frame of reference of the sender. Some messages come from ourselves, that is, we are decoding what we have previously encoded. Some messages come from persons whom we know, and some messages come from strangers. This, of course, is looking at the sources of messages from the standpoint of the pair of perspectives, patient-reciprocal. If we think of writing, or more broadly, of preparing a message, again we need to know whether the message is being done for our own later use, for the use of others whom we know (and whose peculiarities we may wish to take into account) or for strangers. From this standpoint the perspectives pair which is involved is agent-reciprocal.

In designing our educational environment according to the reciprocal perspective, the learner should be led to distinguish among the various possible targets for his messages, and he should be led to discriminate among the various possible sources of messages which come to him. If, for instance, all of the reading material in the educational environment is prepared by anonymous outside experts, then how will the learner have any chance to make the discriminations about which we have been talking? It will not do, either, for all the material to come from the learner himself or from those he knows. Perhaps an illustration may make our meaning plain. In one of our laboratories some of the children were taking dictation at three and four years of age. The children had a chance to learn to distinguish between themselves and others as "dictators." One little boy, who took dictation quite well, his own and others, would at first refuse to recognize himself if he had botched his recording. One moment he would say, "That little boy doesn't speak right," and in the next breath he would take credit for something well done.

Taking the reciprocal perspective seriously encourages us to design the environment so that the learner can come to make clearer distinctions between himself and other people, both in the encoding and decoding of messages. Concretely, this means that the environment must make explicit provision in terms of time, place, and equipment for the learner to produce material (a) for his own exclusive use, (b) for those he knows, and (c) for general consumption, as well as to receive information (a) from himself, (b) from those he knows, and (c) from total strangers, e.g., Mark Twain.

It should be remembered, in terms of either the Meadean or our own theoretical position, that to say the learner should come to make clearer distinctions between himself and other people, does not presuppose that his "self" is a pre-formed finished product. Quite to the contrary, learning to make such distinctions is part of the process whereby the learner develops a sense of self-identity or, in general, a more adequate self.

This account helps us take care of agents, patients, and reciprocators, or so we believe; now how about referees? Clearly, encoding and decoding messages has to be done in accordance with some set of rules, otherwise the messages would be meaningless or garbled. The rules of a natural language and its written counterpart are so difficult to formulate that linguistics has not yet succeeded in adequately characterizing the formal structure of any natural language. Therefore, it is impossible for us to teach the learner the rules of the game in an explicit didactic way.

How are we to handle this? How are we to encourage the learner to view his own acts of communication and those of others from the standpoint of a set of common ground rules? We could, of course, bring in a teacher who would tell the student such things as "Read more clearly," or "That is an improperly constructed sentence." To have a teacher behave in this fashion would provide a referee, a very authoritative referee, but the perspectives principle says that the learner is to be encouraged to take the referee's perspective himself in evaluating his own and other's ongoing activities. In order to get him to assume this stance, what seems to be required is to have breaches of the common rules of communication become problems for the learner. The example above of the little boy who took dictation is to the point. When this boy originally either told a story or read a story (which was being recorded) there was always a strong tendency to criticize him for speaking unclearly, garbling words, and so on. However, his inadequacies became problems to him when he attempted to decipher his own speech. Since the environment was arranged so that he easily could re-do sections of his own recordings, and compare his messages with messages from others, he had the opportunity of assessing and evaluating the adequacy and appropriateness of his own communication.

The idea of making rule violations as a genuine problem to the learner as a step toward getting him to take the referee's perspective seems sound enough, but it does not go to the heart of the problem--it might result only in the learner's taking a rule oriented view of what just happened to become problematic to him. He needs to be placed in a position where he can oversee the whole communication process as it goes on within the environment. To put it another way, he needs to be put in a position that is superordinate to the component processes of communication: reading, writing, listening and speaking (all of which are being carried out in terms of an appropriate variety of message sources and targets).

The referee's perspective suggests, then, that we create a superordinate task which will use the subordinate communications skills as means to accomplish it. The overall task which was set up in several environments was that of publishing a newspaper. (It will be made clear below, when we treat the autotelic principles, that the publishing of a newspaper goes on in what is called a "transfer room," rather than in the autotelic environment per se. Newspaper publishing is not treated as a purely autotelic matter in this transfer room.) This is a task in which the participants not only can use their communication skills, but they have to establish standards for what is published. If the children are permitted to work out their own criteria for interest, relevance, and clarity for the intended audience, they must oversee the whole operation as an umpire would.

To get the newspaper started, two highly competent children, who had been in this special educational environment for three years and who could read, write, type, and take dictation, were selected as editors. When they were five years old they began to publish their own newspaper with some initial assistance from adults. By the time they were seven, another group of five-year olds was ready to start its newspaper. So, instead of having adults help in establishing another newspaper, the two senior editors were asked to select two editors for the paper-to-be, and then to explain to them what the job of editor amounted to. The experienced editors were none too sanguine about the feasibility of explaining anything to children so young, but they agreed to try. They had the satisfaction of knowing that the children with whom they would be dealing were of their own choosing.

A convenient way to get some feel for how the children behave in terms of the referee's perspective is to follow one of their discussions. Given below is a transcript of part of an editors' conference. The cast consists of a seven-year-old girl, Venn, co-editor of the first newspaper; a seven-year-old boy, Jeffrey, co-editor of the first newspaper; Pam, newly appointed five-year-old girl, co-editor of the newspaper; Larry, four-year-old boy, co-editor of the new newspaper. The extent to which four able children can deal meaningfully with the problems of deciding what is "fit to print" (apologies to the New York Times) is indicated in an extended quotation below. But first, a parenthetical remark.

Four children are serving as editors. Explicit provision must be made in the environment for rotating this role, otherwise the opportunity to see what goes on from the editor's desk would be a restricted one.

Plainly enough, some children are prepared to be editors at first and others will come along later. Some may not be up to the job at all, in which case they should be given a chance to rise as high as they can. Also it is important for former editors to serve as contributors who have to put up with editors. One practical way to rotate the role of editor is to have different editors for different issues. We shall now "listen in" on a conversation the children had on the subject.

Editors' Conference

Venn: Jeffrey and I have chosen you two to be the editors of the first-grade newspaper. My first question is, Would you like to be the editors of the first-grade newspaper?

Larry and Pam (in unison): Yesssssssssss!!!!

Venn: Well----one of----the editor is the boss of the newspaper and you are going to be the boss, so, one of the ways to get an article is, you can tell a child----

Larry: What's a child?

Venn: You can tell a child, give a child an idea----

Larry: But what's a child?

Venn: You're a child----

Larry: Oh----

Venn: give a child an idea and he can think about it for a while, or a child can think up his own ideas. He'll type that once he gets it, and then he will give it to you. If there are too many errors, give it back. If it's O.K.--its O.K. But if there's a few errors, correct them. But if there's too many errors--you can't just---

Larry: Correct them?

Venn: correct them or it would be more---

Larry: Could Pam help me, then, correct them?

Venn: Yes---if there's too many you shouldn't correct them because if you did correct them, you might be correcting too many and it would be more of your article than theirs. Once you get a lot of this material, like riddles, poems, jokes, cartoons and---

Jeffrey: And comics---

Venn: and comics, you can choose the ones that--you can both decide the ones that are most interesting and the ones that aren't you leave out, then you type them on stencils--and then when you get all the stencils you run them off on the mimeograph machine. Now, a mimeograph machine is this thing right there.

Larry: How do you work it?

Venn: You'll find out. After you mimeograph it, you collate it. And then you staple it, and then it is ready to give out. And--Pam? Do you have any questions? Pam---

Pam: Well, what if all of them are not too good--what do you do, really?

Larry: (at the same time Jeffrey is talking): You correct all of them---

Jeffrey: You give them back and make them start all over again on a different one.

Venn: As you would if they were wrong, you would send them back---

Pam: Ahhh---

Venn: Before, if they were wrong as we told you---

Larry: All of them?

Pam: Why?

Venn: Because---

Larry: If we get tired then we couldn't be the editors if we got too tired, right?

Venn: Editors--if you are going to be an editor, editors don't get tired!

Larry: But erasing all those things, right? they will---

Jeffrey: On stencils you don't erase--special kind of correcting fluid--

Venn: Stencils are made out of wax.

Larry: I think I've used them before---

Venn: No, Larry---

Larry: But I think I've seen them run once.

Pam: I think he has seen them once, but I'm not quite sure cause I haven't seen them once.

God may allow himself the luxury of resting on the seventh day, but this privilege evidently is not for editors--"Editors don't get tired!" It isn't too often that we have a chance to listen to young children discuss a difficult problem. We find their viewpoints fascinating, leaving aside the little exchange about "What's a child?" the rest is really quite subtle. By the way, the recording of the conference indicates that Venn slurred the word "child" when she first used it--it sounded like "chile." Larry misunderstood her. Also, he may have been surprised by a child using the word "child" because adults generally are the ones who use this term.

It is interesting to contrast the views of the experienced children with the inexperienced youngsters. For little Larry, the main problem he saw in correcting errors was the time and effort it might take--he wanted to be certain he had Pam's help in this. Venn and Jeffrey knew that the sheer physical act of correcting errors, for instance on a stencil, was trivial. As experienced editors their point was the delicate one having to do with human relations and the integrity of other people's work. Venn said it quite well--"If there's too many [errors] you shouldn't correct them because if you did correct them, you might be correcting too many, and it would be more of your article than theirs." Evidently, Venn and Jeffrey feel that at some point an editor would become the contributor if he "corrected" the article too much. The same sort of point was brought up by Pam when she said, "Well, what if all of them are not too good--what do you do, really?" Venn replies that it is the same problem as correcting too many errors. Jeffrey and Venn agree, give it back and have them start over.

It seems to us that all of the editors, especially the experienced ones, are too confident of the "rightness" of their judgments. There is still an absolutistic streak in their attitude toward what it means to be the referee. None of them, at that time, ever had had to put up with an unreasonable editor.[16] It would be intriguing to know whether they would evolve some mechanism whereby contributors who felt they had been unfairly or improperly judged would have some court of appeal. (We did not get to find out because the grant under which we were working ran out the next year.) In any case, the perspectives principle urges us to create opportunities for the learners to get an overview of their environment and to learn to make assessments and evaluations of a normative kind.

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[16] It may come as a surprise to the reader, as it did to us, that the concept of an "unreasonable editor" can be made mathematically precise. As Dana Scott pointed out in a discussion in Ann Arbor in 1955, this fact follows from his work on "A Short Recursively Unsolvable Problem," an abstract of which was published in (1956).

Autotelic Principle--Applications

The most obvious application of this principle is to the physical safety of the children. Since they are permitted to explore the environment freely and much of what they do is self-determined, it is imperative to examine every aspect of the environment for hazards. Naturally enough, the safety of the children is of first importance, but the environment needs some protection, too. We use the somewhat awkward expression "child-proofing the environment" to cover both aspects of this relation--we want the children to be safe, but we do not want to ruin the environment. This is much easier said than done. It has taken as much as three months of engineering time to work out solutions for some seemingly simple problems. For example, the automatic carriage return on the ordinary electric typewriter is dangerous because a tiny child could have his fingers hurt if he is unlucky enough to have them in the wrong place when the carriage snaps back. We designed a clear plastic shield to prevent this from happening. This sounds easy to do, but it takes a good deal of thought to come up with a practical shield which the operator can remove quickly but the child cannot. Most educational environments are not troubled by the safety factor because the children are not given sufficient freedom to get into serious difficulties and the environments are relatively bare.

An autotelic environment must afford the learner more than physical safety--he must be free from various kinds of social pressures. At the very least, this means privacy *vis-à-vis* the authority figures in his life. We can remember very well explaining the autotelic principle to an architect who was to design an autotelic environment for a public school. He seemed to understand what was wanted and in about two weeks he came back with beautiful colored drawings showing an open park-like area which was sprinkled with clear plastic bubbles, each bubble slightly larger than a phone booth, and each bubble containing a child who could see everything around him, and who could be seen by anyone who chanced by. This is not quite the idea.

As most of us can recall from our own childhood, play means both not having to do something and not having to do it in the presence of authorities. The demand for privacy during playtime seems to require children to disappear into cracks between buildings, or cellars, caves, tree houses and other uncomfortable places. They seem to care little about comfort if its sacrifice will purchase some freedom. So the idea is to make a place into which children can disappear during (autotelic) playtime--a place where they cannot be followed by those whom they may be trying to avoid.

There is an indefinitely large number of architectural arrangements which would do for this purpose so long as whatever structure is used is protected by norms which prevent a bossy older sister, a domineering mother, an anxious father, or a meddling grandparent from coming in. Sometimes we have used air-conditioned, windowless, prefabricated buildings as the shell for such environments. Inside there is compartmentalization--there are sound-proofed booths for individuals and larger rooms for groups. Sometimes, rather than constructing a separate building for the environment, we have used space within an existing structure. In either case, the heart of the matter is to delineate clearly the protective boundary of the environment so that even a two-year old will be led to recognize the distinction between being in it and being out of it. This distinction can be conveyed physically in many ways and we try to use as many differences as we can, partly because some children, mentally retarded ones, for example, need all the help they can get to make this distinction. We have used differences in color, texture, temperature, and so on, very freely to define the environmental boundary.

Even if the architecture of the environment spells privacy for the learner, the social norms which define the environment as autotelic must be made clear to him. We have found that most children are more likely to believe what other children say than they are to believe adults when it comes to the question of freedom. Therefore, we rely on children to explain the rules of the environment to newcomers. The rules are simple enough--the problem is to make them credible. The first rule is, you do not have to come here at all. The second rule is, you may leave when you wish. The third rule is, you do not need to explain your comings and goings. These are the basic explicit rules. There are some implicit rules which bind the staff and which may or may not be of direct concern to the learner. The prime implicit rule is that the behavior of the learner in the environment is a private matter for the staff. The learner himself may talk about it in any way he pleases and to whom he pleases. What all this means is that parents, for example, are not allowed to watch their own children, nor do they get reports which would enable them to follow their child's progress in the environment. The children are not graded. Of course, if the staff sees a serious medical, educational or social problem developing, this is promptly brought to the parent's attention. The point is not to neglect measles, or hysteria; it is rather to give the tykes a little time off every day, when they can enjoy learning something without being under the nose of Mommy, or Daddy, or Big Brother.

After a child has been coming to a well-run autotelic environment for some time, he will have learned some things which he may wish to practice. In several of our educational ventures we have designed a kind of half-way station between the world outside the autotelic environment and the autotelic environment per se. We call this a "transfer room" (a concept to which we referred earlier). It is physically and normatively distinct from the basic autotelic environment. It is in the transfer room, for example, that the children publish a newspaper. They begin such activities only after they have learned how to read, type, etc. In the transfer room they practice these skills within the context of some superordinate task. The normative rules for the transfer room might best be described as permissive rather than autotelic. For instance, several groups of youngsters not only published a newspaper but they sold it. The newspaper itself with its signed articles gave parents and others a pretty good idea of what their children were doing and thinking. By definition, a newspaper is not private, but public. The children used the newspaper to gain approval and to express criticism. In brief, there are many kinds of extrinsic rewards and punishments associated with this activity. We think that the transfer room is a valuable adjunct to an autotelic environment if there is any reason to believe that the world outside that environment does not provide adequate opportunities for the learners to apply their skills. An appropriately designed transfer room and suitable transfer-room activities allow for the "transfer" of what is learned within an autotelic environment to problems outside its boundary.

Sometimes the question is asked as to why the children should trust the adults in the autotelic environment to be autotelic toward them if children are assumed to be somewhat distrustful of adults in general. We, of course, do not assume that all children are distrustful of adults. We do assume, however, that most children two years of age and older have discovered that questions such as "Would you like to wash your hands?" are best translated as the imperative "Wash your hands!" We find that children only gradually come to trust the adult staff who manage the environment. It helps to create this trust if the staff avoids taking nonautotelic roles with the children outside the environment. An instructive mistake will show what is to be avoided. In one educational experiment the director reported to us that his children did not behave at all as he would have expected--they did not seem to explore very much, they frequently refused to come to the laboratory, they stayed for relatively short periods of time--evidently something had gone wrong. It turned out that this project director used his laboratory staff in two conflicting roles. Some of them served as part-time bus monitors. As bus monitors they had to discipline the children in a variety of ways to assure the safe operation of the bus. Then these same people would appear in the laboratory as staff members who are carefully instructed not to reward or punish the children. Quite understandably these preschool children were confused. Older, more sophisticated children might have been willing to accept the thesis that one person can wear two hats, but it was asking too much of this particular group. When this was pointed out, the director changed his job assignments appropriately and within a few weeks the behavior of the children became more relaxed, refusal rates went down, and length of stays increased.

It seems to us that the autotelic principle gives some general guidance in constructing the physical side of an educational environment and in formulating its rules and procedures. When we first began to experiment with autotelic environments we held our breath lest the children really would not come back unless they were given candy, gold stars, etc., on the one hand, and threats and punishments, on the other. These environments were not built for a day, a week, or even a month--we hoped the children would find them fascinating for years! We now know that such attractive environments can be built and that the children will come to them for an indefinitely long period of time. If suitable transfer rooms and transfer-room activities are provided, the children can develop exceedingly high levels of skill and they take considerable pride in their accomplishments. An article by a teenager written for a high school newspaper conveys some sense of the way the children felt about their experience in one laboratory. This piece was written by Nancy Jordan, an assistant editor of her paper.

Reading Lab Produces Paper

> The first grade in connection with the reading lab puts out its own newspaper. We felt it might be to our advantage to interview the Staff. We walked in a little apprehensively wondering just what to ask and how to approach our competitors. They seemed to regard us with awe and a little hesitation as to our true intentions. But they were a rather talkative group and it didn't take very long for each to willingly expositate on his contributions and prove an individual superiority.
>
> #### Everyone Contributes
>
> The paper is compiled solely by the children and they seem to regard any assistance as an infringement upon their skill. Everyone in the class is a contributing reporter who types up his own story and then several others type up the sheets for the newspaper itself and run them off on the thermo-fax machine, an instrument whose complexities are clearer to the first-grade than they are to us. We were also proudly told by one interested, lively little girl, "I could type when I was two years old!"
>
> A boy standing nearby not to be outdone added "I learned to type four years ago." Since they are both only six and we are sixteen and hardly able to pluck out a few lines with one finger, we began to feel slightly inferior.
>
> #### Satisfies Literary Needs
>
> The stories are typed in the lab and one of the editors assured me that everybody in the class "liked"

to participate in this sort of literary self-expression. Some of the others appeared more dubious but all were extremely fond of typing and genuinely enjoyed this program.

The development of the paper was adequately expressed in a rather concise sentence by the editors, "Well one day Mrs. Coogan told us a surprise and we were the editors."

Mrs. Coogan helps to correct the articles and when questioned how they knew the spelling of such a variety of words, the response was naturally that they were fully acquainted with the use of the dictionary. They all seemed to think reading and correcting articles was fun or anyway the finding of other people's mistakes. We complimented them on their paper and someone quickly apologized "I saw a little mistake but we decided to skip it."

Sacred Document

By accident a copy of their paper was dropped, a hush fell over the room. Two or three children quickly retrieved the journal with stricken faces for they had an intense pride in their achievement and were not ready to see a product of such hard effort mutilated or destroyed in any way.

We asked for any final comments; first we received a blank stare but then someone kindly volunteered "Well I was thinking if you wanted to use my riddle..." Another boy with a rather dream-like expression said, "I have something to say... I was at the beach and..." As we left we overheard one boy say to a friend, "We were having a meeting!" and with the aptness of childhood logic the other's reply was "Who cares, that's stupid?"

Productive Principle--Application

The guidance which this principle gives us with respect to reading is quite straightforward. It invites us to consider very carefully the structure of what is to be learned. If children are to read, they must break the code that relates the spoken language to the written language (the spoken part having been learned already in an autotelic way; mothers do not send their babies to the Sorbonne for lectures--the babies learn to speak because they find it fun to communicate in some more sophisticated way than crying). For present purposes we will confine ourselves to the

English language as an example, but the reader will see that many of our considerations would carry over to any language with a similar orthography, i.e., a system of symbols designed to mirror speech. Among such we mention Greek, Hebrew, Russian, Arabic, German, Latin--all of which have had, at one time or another, distinctive alphabets: conventional squiggles on paper intended to indicate the sounds made in the course of talking (a writing system quite different from that of the Chinese, mentioned above).

If we ask ourselves whether our present English alphabet is better than some alternative versions of it, we can see at once that it leaves a good deal to be desired. Too few symbols are trying to do too much work. This produces unnecessary ambiguity, which in turn produces confusion for the learner.

Sir James Pitman (1965), the grandson of Sir Isaac Pitman, inventor of the system of shorthand which bears his name, developed an alphabet consisting of 44 symbols, more than enough to represent the 40 phonemes of English. This system is intended to be used as an initial teaching alphabet (i.t.a.) after which the learner is expected to switch over to the conventional alphabet. There is no question about it, Pitman's system is more producitve than the conventional alphabet. It is being used on an experimental basis in our country now. We have not used it largely because the typewriters employed in our work have the standard keyboard. Now some typewriter companies are offering the Pitman symbols.

Besides the question of productivity, there are some other issues which arise with respect to Pitman's system. What happens if some children do not switch easily to the conventional system? Might not some people welcome a group of second-class readers (those who never switched) as targets for exploitation? There are many other issues of this kind which come up when the question is one of adopting or not adopting an innovation on a mass basis. Here, all that we wish to note is that the productivity principle alerts us to alternatives, some of which are clearly superior to the conventional system.

Personalization Principle--Application

Responsive Condition. In applying the responsive condition to the learning of basic communication skills, we will concentrate here on the design of responsive environment equipment. Equipment is not the whole story, but it will be recalled that one of the requirements imposed on an environment in order to qualify it as responsive is that it should permit the learner to explore. We mean that he should be able to explore the entire environment, not just the equipment it may contain.

Suppose we wish to design a machine which will help a child learn to "read." Following our prior application of the perspectives principle, we place reading within the context of the four-fold set of linguistic skills: speaking/listening; writing/reading. We have mentioned five conditions for responsiveness, and we will now attempt to design our machine so that it will satisfy these conditions.

(a) It permits the learner to explore... It seems simple enough to say that the learner should be free to explore and presumably what he is free to explore is our hypothetical machine. Does this mean that he should be free to take the machine apart? Leaving aside the complication that he might hurt himself--a contingency forbidden by our prior application of the autotelic principle--the idea is not to explore the machine as such. Rather, what we want him to do is to explore something else using the machine as a tool or means for exploration. True, he will have to learn something about the machine in order to use it as a tool, but most of the machine's characteristics *qua* machine are irrelevant to the task of enhancing communication skills.

What in the world is it, then, that the learner is to explore? We have agreed to confine ourselves to English, for present purposes. The English orthographic system, as we all know, consists of more than the upper and lower case alphabets--it also has various punctuation marks. What is more, all of these symbols must be used in accordance with certain conventions, such as proceeding from left to right, from top to bottom, and with various kinds of juxtaposition. It is this complex system of English orthography that we want to open up for exploration.

The learner should find it easy to produce any part of it at will; it should be convenient to expose him to it; and whatever is done with it should exemplify its various conventions. Our task, then, as clarified by the responsive condition, is to design a machine which the learner can use to explore this system. When the matter is looked at in this light, it is quite apparent that clever inventors have anticipated us, in part. There already exists an inexpensive, reliable orthographic machine--it is called a "typewriter." It has both the upper and lower case alphabets, standard punctuation, and its mode of operation exemplifies the basic orthographic conventions--its carriage goes from right to left so that the writing proceeds in the approved left to right fashion (of course some typewriters go "backwards," e.g., Arabic typewriters, which are just right for Arabs), the carriage return and the line feed give us the required top to bottom movement, and the appropriate combined use of the space bar, tab, margin settings and carriage return provides for the many conventions pertaining to juxtaposition.

The typewriter is patently the kind of machine that we want but it is inadequate in certain respects. As long as we stay with reading and writing it does well enough, but it makes no provision for speaking and listening. If we are to tie our four linguistic processes together then the capabilities of the typewriter must be extended. It needs a voice so that the learner can begin his exploration of the complex relations holding between the spoken and written forms of English. It also needs some of the attributes of dictation equipment, that is, it needs a recording-reproducing component. It needs all of these capabilities if the system to be explored is not just English orthography, but English orthography combined with spoken English. The "talking typewriter," which we promised to place in perspective, represents a first step toward the construction of an adequate responsive machine to be used as a part of an overall clarifying environment in which the learners have the opportunity to acquire basic communication skills.

Returning for the moment to the topic of English orthography, let us think a little bit about the keyboard of our "orthographic machine."

The responsive condition urges that we use a full keyboard so that the learner can explore freely the alphabets and punctuation.

Although we know that there are conflicting views about exposing the full standard keyboard to the learner, we still believe that this is a useful way of introducing children to the kind of thing they find in books. We have, indeed, had encounters with prominent and highly respected authorities who object strenously to this idea. We recall vividly long discussions with them about exceptional children, their feeling being that a retarded child would be overwhelmed by a full keyboard. They wanted to cover the keyboard, except for perhaps two or three letters at first, and when their "subjects" had learned these letters, they could move on to others. Finally, after the alphabet was mastered, they conceded that it might be advisable to teach a few punctuation marks.

Their argument has a plausible ring to it--also, it surely is an empirical matter to determine how much of a system a learner should be exposed to initially. Nevertheless, the responsive condition suggests that we allow free exploration. Why? The basic answer is that we presuppose that the what of what is to be learned constitutes a system and not a random or miscellaneous collection of things. This is certainly true of language both in its written and spoken forms and their interrelations. Language is a system. If language is presented in such a way that its systemic properties are hidden or obscured, the learner may fail to master it. The more stupid the learner, the more essential it is to make these systemic properties evident. With respect to orthography the punctuation marks are the basic "traffic" signs which govern the flow of the symbols of the linguistic code, e.g., stop, go, caution. The distinction between upper and lower case letters is also part of this system of traffic signs. We asked these authorities whether they thought these symbolic traffic signs were most needed by the gifted or the retarded. They thought that the gifted had less need for explicit well-marked symbolic highways. Agreed! But it was precisely the retarded who were to be deprived of the opportunity to come in close contact with periods, commas, question marks, exclamation points, and other aids!

In designing the keyboard for the talking typewriter, provision was made for an overlay to cover the keys so that they can be exposed selectively. We made this provision because we knew that for some research purposes, the total keyboard would be too much or somehow irrelevant. Nevertheless, free exploration means _free exploration of a system_. On the negative side, it can serve as a warning that restricted exploration entails the risk of the learner not coming to grips with whatever it is he is to master.

(b) _It informs the learner immediately about the consequences of his actions_.... This condition, like the one above, is related to the notion of a system. We really do not mean that the learner is to be informed about _all_ the consequences of his actions--this would be an impossible requirement. What we mean is that the consequences of the learner's actions which are _directly relevant_ to the linguistic system which he is learning are to be reported back to him. For example, it is relevant to the relation holding between English orthography and English speech that the written C-A-T is pronounced as we generally say it. Hence, if the learner writes C-A-T he should hear it as well as see it. This connection should be as close as possible--we can easily obtain a verbal response from the machine in a little less than 1/10th of a second, and for many purposes this is fast enough.

There is a deeper point here, though, than the one having to do merely with the machine's speed of response, namely, it has to do with making it manifest to the learner that the pronunciation of the word _cat_ is a consequence of his having typed C-A-T. After hitting the final "T" he might steike another key. How does he know that the verbal consequence had nothing to do with his final action? He cannot be certain unless the machine is designed so that for varying periods of time we can block or stop all machine actions except those that are consequential _vis-a-vis_ certain actions of the learner. In our simple-minded illustration here, we need to provide for the blocking of the keyboard until the pronunciation of "cat" is complete, otherwise the learner will find it very difficult to trace the consequences of his own actions. The selective blocking of various machine functions at certain times, depending, of course, on what the learner has done will help make it evident to him that some things are system-relevant consequences of his actions, and certain other things are not. From an engineering standpoint, this blocking of machine functions is again one of those things which is much easier said than done. This condition which we place upon a responsive environment may simplify things for the learner but it leads to nightmarish engineering problems if the system handled by the equipment is at all complex.

The talking typewriter as a responsive environments device has within it explicit provision for the blocking of machine functions so that the learner can find out more easily what follows from what.

(c) It is self-pacing.... Many instructional systems are not at all self-pacing, for example, educational T-V. Self-pacing devices must have controls for the learner himself. The concept of self-pacing should go beyond the mere slowing down or speeding up of a process. It should include controls suitable for bringing about both the repetition of sequences and scanning ahead. The controls for office dictation equipment are a good example of what is wanted--with a touch of a finger the operator can stop, repeat, go forward normally, and speed forward or backward. It is this kind of flexibility that gives practical reality to the notion of self-pacing. We will want to include appropriate self-pacing controls in our machine--they should be at least as flexible as those built into standard dictation equipment.

(d) It permits the learner to make full use of his capacity for discovering relations.... It is easier to say what this condition does not mean than to state its positive attributes. The trouble is, we know so little about human capacities. However, we can be reasonably certain that our machine is not drawing upon these capacities if the learner is told what to do, how to do it, and what to think about what he has done.

The notion of discovery carries the connotation of obtaining the sight or knowledge of something for the first time. Many present-day machines falling under the general educational classification of "computer-aided instruction" are quite frankly for drill, not discovery. Drill undoubtedly has its place in education; no one could possibly learn to spell or play a musical instrument without it, but drill is not what we are talking about when it comes to the notion of a responsive environment.

It is very hard to decide how far one can go in making things clear to the learner without spoiling his chance of making a discovery. Let us return to the keyboard of our hypothetical machine. Imagine that we place a light under each key. Now, suppose that whatever key should be struck next, say, for the spelling of Mississippi, lights up. The subject probably would notice this very quickly--a small discovery in itself. The trouble with this discovery, at least as far as spelling is concerned, is that it eliminates the need for any further discoveries. A pigeon could learn to peck only the lighted key and he could get along just fine without learning anything about English orthography. We have placed three fringe lights on the keyboard of the talking typewriter: one for upper case, one for lower case and one for space bar. These lights (which can be turned off or made to blink) are not there to tell the learner what to do next, as was true in the case of the pigeon example, but to signal the major states of the system for which there are virtually no visual clues provided otherwise by the system.

There are many other clues which we can build into our keyboard without eliminating the need for further discoveries. For example, since the learner will eventually be able to type and it is convenient to use standard typing conventions, we can color code his fingers to match a color coding of the keys. This means that by striking the right keys with the right fingers he will be learning "correct fingering." To give him a clue about the proper domain of keys for each hand a noticeable pressure difference can be made between the left- and right-hand keys. This clue can help him orient his hands.

Notice that the clues that we have mentioned, namely, the left-hand-right-hand pressure difference, the matched color-coding of keys and fingers, and the fringe lights, serve to help the learner to master the machine. They neither give away secrets about the mysteries of orthography nor do they obviate the need to make discoveries about them.

(e) It is so structured that the learner is likely to make a series of interconnected discoveries.... What is emphasized in this condition is the idea of interconnectedness among discoveries. We want the learner to be put in a position where he can use the results of one discovery for making the next, and so on. In effect, if you think of him as playing a kind of game with the machine, then it must be possible to change at least some of the rules quickly, and turn the situation into a new game.

This condition suggests that the machine's supervisor, as opposed to the user of the machine, must have a set of remote controls. Let us imagine that some learner is playing happily with the individual characters of the orthographic system. However, suppose also that there are signs that he has just about mastered these characters in the sense that he can accurately match the visual to the auditory, and vice versa. Before long he will tire of this. If the supervisor must stop the learner while he changes the machine, then this is a clumsy interruption--it tells the learner to expect something. If, instead, the supervisor can throw some switches at a remote station, the learner will suddenly find himself confronted with a new problem. It will be up to him to notice that something has gone wrong and to work out a new pattern of play. If the new game bears no relation to the old, then the results of learning will not be cummulative, so we have to decide what of the old should be carried over into the new situation.

In the case of English orthography it is a straightforward matter to use letters to make words, words to make sentences, sentences to make paragraphs and from there to many different kinds of higher-order entities. Games can be played at each level and the transition from level to level can be turned into a new opportunity for discovery. So our machine must be flexible enough to handle a series of interconnected language games.

As was remarked before, it is best if the transition from game to game can be controlled from a remote station. In the talking typewriter provision has been made for just such a series of remote control transitions. At the simplest level the mechanical system can handle games with individual characters of the orthography up to games at the level of paragraphs and stories.

From what has been said about the application of the responsive condition it should be perfectly evident that there are an indefinitely large number of different machines which could satisfy the various requirements for "responsiveness." It should be equally clear that the human personality can serve as a "responsive instrument," too.

There is one danger to which we would like to call your attention concerning all of this, namely, there is the risk of assuming that since a particular machine can be used as part of a responsive environment that it necessarily will be so used. The talking typewriter is a case in point. It can be a useful part of a responsive environment if it is properly programmed. However, it can be programmed so that it negates each and every condition for responsiveness. It can (a) limit exploration, (b) mislead the learner about the consequences of his actions, (c) force someone else's gait on the learner, (d) make it unnecessary for the learner to make discoveries, and (e) make it difficult for the learner to build upon his insights.

Reflexive Condition. There is a good deal being said these days about individualized instruction. There are those who maintain that one of the principal contributions which advanced technology can make to education is through the exploitation of the capacities of computers to treat each learner as a class of one. Each learner can be branched off in ways that are appropriate for him--there is to be an educational "prescription" written for each student. In principle, no two students need have the same prescription.

We are very much in favor of such individualization, but there are further distinctions to be made. Let us suggest, in terms of the reflexive condition, that what is wanted is a personalized, as opposed to a merely individualized, instructional milieu. According to the reflexive condition the educational environment should be so constructed that it is convenient for the learner to acquire a historical knowledge of himself as he develops over time. He should come to see himself as having a career as a learner. The various perspectives which he can assume as agent, patient, reciprocal other and referee should come to be seen as parts of a personality system, namely, his own personality.

Concretely, how are we to go about designing reflexiveness into our environment so that the learner will come to see himself developmentally? One of the first things that comes to mind, because of its use in sports, is to exploit the resources of sound-color motion picture photography. The same films which the investigator may want as part of his documentation of laboratory procedures and results can be shared with the learners. In one laboratory, for instance, we constructed a learning booth with an automatic photographic system for the making of high-quality 16mm sound-color motion pictures. Learners were then shown films of themselves in various phases of their learning experiences. Their interest, as you might expect, was extremely high. There is no question in our minds that this was an enlightening experience for them. But this is only one step in the right direction. Are we simply to try for complete photographic coverage? Are we to show learners everything that they do? Clearly, this would be both uneconomic and self-defeating. This would lead toward vicious circularity with learners watching themselves watching themselves, and so on. Of course, the high cost of film making would keep this reflexive process from becoming absurd. However, on the positive side, we need some direction with respect to the appropriate use of reflexive techniques.

Let us remind ourselves of our goal as it is defined by the reflexive condition. We want the learner to see himself develop over time, to see his own personality as a whole. This means that he needs to see himself in perspective. You will recall that in our previous discussion of the perspectives principles, we stipulated that the learner should find it convenient to engage in acts of agency, to be patient to events, to see himself through the eyes of others, and to evaluate his conduct from the standpoint of a referee. Now, in terms of the reflexive condition, he should be encouraged to see himself learning to do these same things. Therefore, if we are, for instance, using photographic techniques, we need to sample his behavior as an agent, as a patient, etc.

To be specific about this, imagine that we have 1000 feet of sound-color motion pictures of a learner. Assume that in accordance with the reflexive condition we want to help him develop a sense of history about

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himself. So, let us place the learner in the position of a film editor. Let us ask him to select 250 out of the 1000 feet for his own film library. Next, let us have the laboratory staff select 250 feet from this same 1000. Next, let some significant person in the learner's life select 250 feet from the 1000. (We have to be careful here so as not to violate the autotelic principle.) Let all of these selections be made independently--each "editor" is to act without knowledge of the others. Further, let both the filming and the editorial work continue over some reasonably long period of time so that the learner has had an opportunity to develop and increase his degree of skill and sophistication. Let us make one further assumption--we shall stipulate that each editor who selected from the basic film stock operated under the instruction to produce a film that is characteristic of the learner. We have now reached the point for the learner and the other editors to be patient to the consequences of the others' acts of agency. The learner will have the opportunity to see himself as others see him. We then can make it possible for him to make a new set of selections, that is, to make a new film, one that takes into account what others noticed about him. He may want to go back to the original footage and look for aspects of himself which everyone has neglected.

All of the foregoing may sound hopelessly expensive and time consuming but with the advent of video tape and convenient editing devices this is not so impractical. In any case, in discussing the reflexive condition, as in the discussion of each of the other principles, the basic idea has been to illuminate possibilities. A clearer understanding of what is possible and desirable will undoubtedly have an effect on the development of appropriate technology.

Conclusion

Now that the reader has been hauled through this essay, probably kicking and screaming for all we know, what is it that he is supposed to have gotten from this panoramic view of our position, besides intellectual indigestion? For one thing, we hope that we have made good on our promise to show the talking typewriter for what it is, namely, a social science invention. We hope the reader agrees that there is scientific continuity holding between the contributions of Mead and Simmel and our own efforts. Our most important aim, however, has been to make plausible the contention that it is our general theoretical or heuristic orientation which led to the formulation of principles for the design of clarifying environments, and to the illustrative applications of these principles. If we have accomplished this, then our main goal has been reached.

We yield to no one (for the second time in this paper) in feeling dissatisfied with the lack of formal rigor which pervades our whole enterprise. But, being perennial optimists, despite all the common-sensical grounds for pessimism, we trust that we will become more sure-footed as we proceed.

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